Prince Sultan University
CCIS - Department of Computer Science

Major Exam 2
Term 241

Course Title: Data Structures and Algorithms **Course Code**: CS 210

Exam date: 04/11/2024 **Exam Time: 60** minutes

Student Name:

Student ID:

Serial Number:

Question Number	CLO	Question points	Score
Question 1	**CLO 1**	4	
Question 2	**CLO 3**	4	
Question 3	**CLO 4**	7	
Total out of		**15**	

Instructions:

- This exam contains three questions with multiple parts.
- Time allowed: 50 minutes
- Closed Book, Closed Notes.
- Use of Calculators and/or computing devices/smartphones etc is strictly prohibited.
- Answer the problems on the exam sheets only. No additional attachments would be accepted.
- If you need extra space use the back of a page.
- When the "time is over" is called, it is students' responsibility to submit their exam to the invigilator. Submitting a completed exam 3 minutes after the "time is over" will incur a penalty of **5 points**.
- Do **NOT** use erasable pens!

A few gentle reminders:

- If you get stuck on some problem for a long time, move on to the next one.
- The ordering of the problems is somewhat related to their relative difficulty. However, the order might be different for you!
- You should be better off by first reading all questions and answering them in the order of what you think is the easiest to the hardest problem.
- Keep the points distribution in mind when deciding how much time to spend on each problem.

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For All MCQ Questions, COPY your answers in this area only. DO NOT write answers anywhere else (it will not be graded).

Q1 – Part A	**1.**	Ⓐ Ⓑ Ⓒ Ⓓ
	2.	Ⓐ Ⓑ Ⓒ Ⓓ
	3.	Ⓐ Ⓑ Ⓒ Ⓓ
	4.	Ⓐ Ⓑ Ⓒ Ⓓ
Q1 – Part B	**5.**	Ⓐ Ⓑ Ⓒ Ⓓ
	6.	Ⓐ Ⓑ Ⓒ Ⓓ
Q2 – Part A	**7.**	Ⓐ Ⓑ Ⓒ Ⓓ
	8.	Ⓐ Ⓑ Ⓒ Ⓓ
	9.	Ⓐ Ⓑ Ⓒ Ⓓ
Q3 – Part A	**10.**	Ⓐ Ⓑ Ⓒ Ⓓ
	11.	Ⓐ Ⓑ Ⓒ Ⓓ
	12.	Ⓐ Ⓑ Ⓒ Ⓓ

Question 1 [/ 4 Points]

Part A: (/ 2 points)

Answer the following MCQs

1. Which of the following sorting algorithms is most suitable for nearly sorted data?			
A) Selection Sort	B) Insertion Sort	C) Merge Sort	D) Quick Sort
2. Which sorting algorithm has the lowest worst-case complexity?			
A) Selection Sort	B) Insertion Sort	C) Merge Sort	D) Quick Sort
3. If an array has all elements equal, what is the time complexity of Quick Sort?			
A) O (1)	B) O (n)	C) O (n log n)	D) O (n^2)
4. In Selection Sort, how many swaps are made in the worst case to sort an array of n elements?			
A) O (1)	B) O (n)	C) O (n log n)	D) O (n^2)

Part B: (/ 2 points)

Consider the following code snippet for Quick Sort:

```
int partition(int arr[], int low, int high) {
    int pivot = arr[high];
    int i = (low - 1);
    for (int j = low; j < high; j++) {
        if (arr[j] <= pivot) {
            i++;
            int temp = arr[i];
            arr[i] = arr[j];
            arr[j] = temp;
        }
    }
    int temp = arr[i + 1];
    arr[i + 1] = arr[high];
    arr[high] = temp;
    return i + 1;
}
```

5. What will be the array content after the partition function is called with arr = {10, 7, 8, 9, 1, 5}, low = 0, and high = 5?			
A) {1, 5, 10, 7, 8, 9}	B) {1, 5, 7, 8, 9, 10}	C) {5, 1, 8, 9, 10, 7}	D) {1, 5, 8, 9, 10, 7}

Consider the following code snippet for Merge Sort:

```
void merge(int arr[], int l, int m, int r) {
    int n1 = m - l + 1;
    int n2 = r - m;
    int L[] = new int[n1];
    int R[] = new int[n2];

    for (int i = 0; i < n1; i++)
        L[i] = arr[l + i];
    for (int j = 0; j < n2; j++)
        R[j] = arr[m + 1 + j];

    int i = 0, j = 0, k = l;
    while (i < n1 && j < n2) {
        if (L[i] <= R[j]) {
            arr[k] = L[i];
            i++;
        } else {
            arr[k] = R[j];
            j++;
        }
        k++;
    }

    while (i < n1) {
        arr[k] = L[i];
        i++;
        k++;
    }

    while (j < n2) {
        arr[k] = R[j];
        j++;
        k++;
    }
}
```

6. If the merge function is called with arr = {5, 8, 6, 3, 7} and l = 0, m = 1, and r = 4, what will be the content of arr after this call?

A) {3, 5, 6, 7, 8}	B) {5, 6, 3, 7, 8}	C) {5, 8, 3, 6, 7}	D) {5, 6, 7, 8, 3}

Question 2 [/ 4 Points]

Part A: **(/ 1.5 points)**

7. What values are returned during the following series of stack operations, if executed upon an initially empty stack? **push(10), push(4), pop(), push(6), push(7), pop(), pop(), push(12), push(3), pop(), push(8), push(9), pop(), pop(), push(5), pop(), pop()**
A) 4, 7, 6, 3, 9, 8, 5, 12.
B) 4, 6, 7, 3, 9, 8, 12, 5.
C) 4, 7, 9, 3, 6, 5, 8, 12.
D) 4, 7, 6, 3, 9, 8, 12, 5.

8. What is the content of the queue after the following sequence of queue operations, if executed on an initially empty queue? **enqueue(15), enqueue(7), dequeue(), enqueue(11), enqueue(20), dequeue(), enqueue(25), enqueue(9), enqueue(3), dequeue(), enqueue(14), enqueue(18), dequeue(), enqueue(5), enqueue(6), dequeue(), dequeue(), enqueue(8), dequeue(), dequeue()**
A) [14, 18, 5, 6, 8].
B) [18, 5, 6, 8].
C) [25, 14, 18, 5].
D) [18, 5, 6].

9. You are implementing a logging system that stores only the last 5 minutes of error messages. Each error message has a timestamp in seconds. Every time a new error is logged, the system should remove any old errors that fall outside the 5-minute window. Which data structure is most efficient for implementing this feature?
A) Stack.
B) Queue.
C) Array.
D) Binary Search Tree.

Part B: **(/ 2.5 points)**

You are managing a tech support center that handles two types of customer inquiries: 'Software Issues' and 'Hardware Issues'. Initially, there are two queues: 'SoftwareQueue' and 'HardwareQueue', containing customer inquiries for each category. Your task is to manage these inquiries and organize them into a single stack called 'ResolvedIssues' to keep track of issues that have been resolved.

Write the sequence of operations needed to achieve the final configuration of the 'SoftwareQueue', 'HardwareQueue', and 'ResolvedIssues' structures.

Initial queues:

Queue 'SoftwareQueue':

Antivirus Installation	OS Update	Software Crash		

front

Queue 'HardwareQueue':

Printer Not Working	Broken Keyboard	Monitor Flickering		

front

Final configuration:

Queue 'SoftwareQueue':

OS Update	Software Crash			

front

Queue 'HardwareQueue':

Broken Keyboard				

front

Stack 'ResolvedIssues':

Monitor Flickering
Printer Not Working
Antivirus Installation

Question 3 [/ 7 Points]

Part A: **(3 / points)**

Answer the following MCQs

10. The following three are known to be the preorder, in-order and post-order sequences of a binary tree. But it is not known which is which. I. MBCAFHPYK II. KAMCBYPFH III. MABCKYFPH
A. I and II are preorder and in-order sequences, respectively.
B. I and III are preorder and post-order sequences, respectively.
C. II is the in-order sequence, but nothing more can be said about the other two sequences.
D. II and III are the preorder and in-order sequences, respectively.

11. Consider a node X in a Binary Tree. Given that X has two children, let Y be the immediate successor of X. Which of the following is always true about Y?
A. Y has no right child.
B. Y has no left child.
C. Y has both children.
D. None of the above.

12. Suppose that we have numbers between 1 and 100 in a binary search tree and want to search for the number 55. Which of the following sequences CANNOT be the sequence of nodes examined??
A. {10, 75, 64, 43, 60, 57, 55}.
B. {90, 12, 68, 34, 62, 45, 55}.
C. {9, 85, 47, 68, 43, 57, 55}.
D. {79, 14, 72, 56, 16, 53, 55}.

Part B: **(4 / points)**

Consider a BST with the following elements: 10, 13, 15, 14, 7, 6, 4, 9, 8. Please do the following:

- **Draw** the BST by **inserting** the keys in the **order that is listed**. After inserting all elements **delete 10 and 7** from the final tree. **[/ 3 points]**

- Please give the final array representation of this tree after completing the above insertion and deletions. **[/ 1 point]**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

********** End of Exam **********